part of the Examiner, in view of original claim 9 that included the use of a catalyst comprising molybdenum and nickel in ultra-deep HDS.

Rejection Under 35 USC § 103

Developing processes for ultra-deep HDS has been uncharted territory. Feeds with a sulfur content below 500 ppm generally are feeds which have already been subjected to a hydrodesulfurisation step. In that step, the reactive sulfur containing compounds, viz., the sulfides and disulfides, are removed, followed by the thiophenes and benzothiophenes. The sulfur compounds present in feeds with a sulfur content of below 500 ppm are mainly made up of dibenzothiophenes, more in particular dialkyldibenzothiophenes, which are very stable, non-reactive compounds.

As a matter of thermodynamics it is always more difficult to remove a compound present in a low concentration as compared to a compound present in a higher concentration. In the case of removing sulfur from hydrocarbon feeds, this effect is compounded by the situation discussed above, namely that all "easy" compounds have already been removed, leaving only the very hardest to be handled.

The process of the present invention effects reduction of the sulfur content of a hydrocarbon feedstock having a sulfur content of 500 ppm or less to a value of less than 200 ppm by contacting it with a catalyst comprising molybdenum and nickel and an organic additive. This is based on the surprising discovery that the activity ranking for ultra-deep HDS differed from the activity ranking known for conventional HDS. In other words, the catalysts with the best performance in conventional HDS did not show the best performance in ultra-deep HDS.

That surprising discovery is illustrated by the Declaration of Franciscus Wilhelmus van Houtert submitted herewith. It is shown in this Declaration that in conventional HDS with a feedstock having a sulfur content well over 500 ppm (13891 ppm), a Ni-Mo additive catalyst produces a product with significantly higher sulfur content than when a Co-Mo additive is employed.

For example, in conventional HDS, cobalt-molybdenum catalysts are more active than nickel-molybdenum catalysts. However, in ultra-deep HDS it appeared that nickel-molybdenum catalysts are more active than cobalt-molybdenum catalysts. It appeared that while conventional hydrodesulfurisation mainly takes place via direct sulfur removal from the organic molecule, ultra-deep hydrodesulfurisation mainly takes place via a hydrogenation reaction followed by sulfur removal.

The attached Declaration of Franciscus Wilhelmus van Houtert provides data that illustrates the surprising superiority of a Ni-Mo additive catalyst as compared to a Co-Mo additive catalyst in ultradeep HDS. The Co-Mo additive catalyst exhibited superiority where the sulfur reduction in a diesel feedstock was in the range of greater than 200 ppm S in the product. However, when ultradeep HDS was employed to obtain a product containing less than 200 ppm S, the Ni-Mo additive catalyst exhibited very substantial superiority.

Although the comparison tests for ultradeep HDS employed feedstock having in excess of the 500 ppm or less as required by the instant claims, the tests are no less convincing with regard to illustrating the superiority of the Ni-Mo additive catalyst. Obviously, at some point in the conducting of the tests the S content of the feed was 500 ppm or less. The high S content of the feedstock for the ultradeep-HDS tests in fact shows the capability of the Ni-Mo additive catalyst in reducing the S content to less than 200, even in a far more rigorous application than associated with the instant claims.

The cited reference Yamaguchi et al. (US 5,468,709) discloses a hydroprocessing catalyst that contains a Group VI metal, a Group VIII metal, alumina as support, phosphoric acid, and an additive. The additive is selected from dihydric or trihydric alcohols having 2-10 carbon atoms, ethers thereof, mono-, di- and polysaccharides (col. 4, lines 45-61). The catalyst is used in hydrodesulfurization of a light gas oil containing 1.15 wt.% of sulfur, and a vacuum gas oil containing 2.87 wt.% of sulfur (col. 9, lines 59-60; col. 47, lines 49-50).

In a very important respect, the subject-matter of claim 1 is different from the disclosure of Yamaguchi et al. in that the process of claim 1 is an ultra-deep hydrodesulfurization process, in which the sulfur content of a hydrocarbon feedstock originally containing 500 ppm or less of sulfur is reduced to below 200 ppm. Yamaguchi et al. gives no hint to ultra-deep hydrodesulfurization treatment of a hydrocarbon feedstock originally containing 500 ppm or less of sulfur to obtain a hydrocarbon having a sulfur content below 200 ppm Therefore, as the Examiner has acknowledged, the subject-matter of the present application is novel over the disclosure of Yamaguchi et al..

The catalyst of Yamaguchi et al. employs additive, but for desulfurization the catalyst only shows Co-Mo and the desulfurization is for a high sulfur feedstock, involving reactions totally different from the reactions of Deep HDS. For one to combine '709 with EP 0 870 817, one would have to arbitrarily disregard the teaching in '709 of the use of Co for desulfurization as well as jump to the conclusion that additive that helps the HDS reactions for high S content feedstock would also help the unrelated Deep HDS reactions, even when the respective metals compositions are different for use in desulfurization as disclosed in the two references.

As explained in the application (page 2, line 7-page 3, line 20), it is well-known to the skilled person that the reactivity of the various S-containing compounds in a hydrocarbon feed to hydrodesulfurization is very different. This means that as hydrodesulfurization proceeds, first the S-containing compounds that are the most reactive are removed from the feed, followed by the removal of compounds having moderate reactivity, and finally by the removal of compounds having very low reactivity. Consequently, in ultra-deep hydrodesulfurization, where the concentration of S-containing compounds is very low, those S-containing compounds are present which are the most difficult to remove by hydrodesulfurization. Thus, there is no direct relationship between catalytic activity in conventional hydrodesulfurization and catalytic activity in ultra-deep hydrodesulfurization and for all practical purposes the two processes are unrelated and chemically distinct.

There would thus be no incentive for one of ordinary skill in the art to use in ultra-deep hydrodesulfurization a catalyst that is active in conventional hydrodesulfurization, and so arrive at the present invention, and, therefore, the claimed invention could not be considered obvious over the teachings of Yamaguchi et al.

Furthermore, it would be incorrect in accordance with established law to say that it would be obvious to try the organic additive disclosed by Yamaguchi et al. in a catalyst for use in ultra-deep hydrodesulfurization. A rejection based on "obvious to try" that does not take into account the non-obvious properties of the materials involved has consistently been defeated. See, e.g. *Jones et al. v. Hardy,* 220 USPQ 1021.

EP 0 870 817 A describes a process for reducing the sulfur content of hydrocarbon feedstocks to a value of less than 500 ppm, or optionally less than 200 ppm (p. 2, lines 28-29; Example), in which process a feedstock with a 95 %

boiling point of 450°C or less and a sulfur content of 0.1 wt.% or more is contacted in the presence of hydrogen at elevated temperature and pressure with a first catalyst comprising a Group VIB metal component and a Group VIII metal component on an oxidic carrier, after which at least part of the effluent from the first catalyst is led to a second catalyst comprising a Group VIB metal component and a Group VIII metal component on an oxidic carrier which comprises 1-15 wt.% of silica, based on the weight of the catalyst (Abstract; claims 1,2). The presence of silica in the carrier of the second catalyst results in an increased hydrodesulfurization activity (Example).

EP 0 870 817 A does not disclose or suggest a hydrodesulfurization process where the catalyst used contains an organic additive. For reasons given above, there is absolutely no incentive for one skilled in the art to use the organic additive of Yamaguchi et al. in the catalyst of EP 0 870 817 A. The process of the present invention, in which the use of a catalyst containing an organic additive is critical, is certainly novel and unquestionably non-obvious over this reference in view of Yamaguchi et al.

Conclusion

The reasoning of the Examiner regarding obviousness of the present invention over Yamaguchi et al or over the combination of Yamaguchi et al. and EP 0 870 817 A. is clearly incorrect. As discussed above, a skilled person would have no reason to expect that using an additive that increases catalytic activity in ordinary hydrodesulfurization would also result in an increasing activity in ultra-deep hydrodesulfurization. Therefore, the claimed subject-matter is non-obvious over Yamaguchi et al or the combination of Yamaguchi et al. and EP 0 870 817 A.

It is respectfully requested that instant claims 1-9 be allowed and that the present application proceed to issue in due course.

Respectfully submitted,

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Appendix A, Marked-up Version of Amended Claim

1. (amended twice) A process for the ultra-deep hydrodesulfurization of a hydrocarbon feedstock to a sulfur content of less than 200 ppm, comprising subjecting a catalyst comprising a ~~Group VIB metal~~ molybdenum component, a ~~Group VIII metal~~nickel component, and an organic additive on a carrier to a sulfidation step, and contacting a feedstock with a 95% boiling point of 450°C or less and a sulfur content of 500 ppm or less with the sulfided catalyst under conditions of elevated temperature and pressure to form a product with a sulfur content of less than 200 ppm.

8. (amended) A two-step process for converting a starting feedstock having a sulfur content of above 0.1 wt.% into a product having a sulfur content of 200 ppm or less, wherein the process comprises sulfidation of a first and a second catalyst said first catalyst comprising a Group VIB metal component, a Group VIII metal component, and an organic additive on a carrier, and said second catalyst comprising a molybdenum component, a nickel component and an organic additive on a carrier, contacting a feedstock with a 95% boiling point of 450°C or less and a sulfur content of 0.1 wt.% or more with the first sulfided catalyst under conditions of elevated temperature and pressure to form a product with a sulfur content of less than 500 ppm, and contacting the effluent from the first catalyst, optionally after fractionation or intermediate phase separation, with the second sulfided catalyst under conditions of elevated temperature and pressure to form a product with a sulfur content of less than 200 ppm.